

# Elliptic flow and nuclear modification factors of D-mesons at FAIR\*

T. Lang<sup>1</sup>, H. van Hees<sup>1</sup>, J. Steinheimer<sup>2</sup>, and M. Bleicher<sup>1</sup>

<sup>1</sup>FIAS, Frankfurt, Germany; <sup>2</sup>Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

The CBM experiment at FAIR will provide new possibilities for D-meson observables in heavy-ion collisions at low collision energies and high baryon densities. To predict D-meson observables in this environment we apply a Langevin approach for the transport of charm quarks in the UrQMD hybrid model [1]. Due to the inclusion of event-by-event fluctuations [2] and a full (3+1) dimensional hydrodynamical evolution, the UrQMD hybrid approach provides a realistic evolution of the matter produced in heavy ion collisions. As drag and diffusion coefficients for the Langevin approach we use a resonance model for elastic heavy-quark scattering [3] and assume a decoupling temperature of the charm quarks from the hot medium of 130 MeV, which has already been successfully applied at RHIC and LHC energies [4]. The hadronization of charm quarks to D-mesons is included by a coalescence mechanism. To account for the high baryon chemical potential at FAIR-energies we use fugacity-factors in our calculation. Therefore we multiply the anti-charm drag- and diffusion-coefficients by  $e^{\mu_B/T}$  and the charm coefficients by  $e^{-\mu_B/T}$ . Here  $\mu_B$  is the baryon chemical potential of the surrounding quarks and  $T$  is the local temperature of the medium.

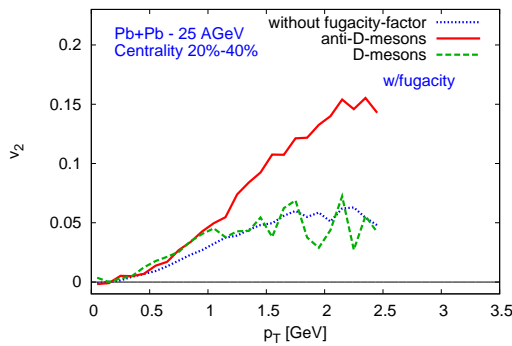


Figure 1:  $v_2$  of D-mesons and  $\bar{D}$ -mesons in Pb+Pb collisions at 25 AGeV using fugacity-factors. We use a rapidity cut of  $|y| < 0.35$ .

Fig. 1 shows our results for the elliptic flow and Fig. 2 for the nuclear modification factor, both in Pb+Pb collisions at 25 AGeV. Our calculation shows a strong difference between D-mesons and  $\bar{D}$ -mesons. The elliptic flow of  $\bar{D}$ -mesons reaches up to 15% and that for D-mesons

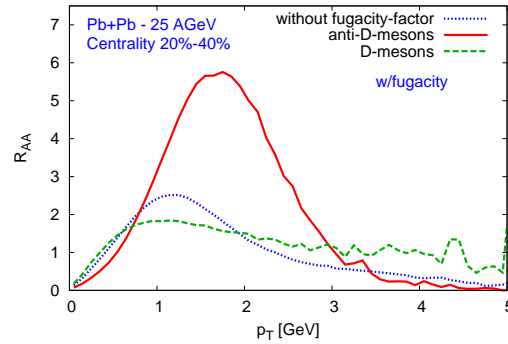


Figure 2:  $R_{AA}$  of D-mesons and  $\bar{D}$ -mesons in Pb+Pb collisions at 25 AGeV using fugacity-factors. We use a rapidity cut of  $|y| < 0.35$ .

about 5%. If we have a look on the difference between the D-mesons and the calculation neglecting fugacity-factors we realize that the difference is much smaller than for  $\bar{D}$ -mesons. This small difference is not due to a small difference of the coefficients used, but to the role of the coalescence mechanism that accounts for the overwhelming fraction of the flow of D-mesons if the coefficients are small. The medium modification in our calculation is considerably stronger than at RHIC and LHC energies [4]. We relate this to the very soft initial momentum distribution of the charm-quarks and the slower bulk medium evolution at FAIR energies compared to RHIC and LHC energies. In the  $R_{AA}$  this results in a strong suppression at low  $p_T$  due to a “heating-up” of the charm quarks.

We should mention that the difference seen between D-mesons and  $\bar{D}$ -mesons is sensitive to the model used to calculate the drag- and diffusion-coefficients. In case of the  $T$ -Matrix approach applied [5] this difference should not arise. Therefore D-meson measurements at FAIR can provide an excellent test for a confirmation or rejection of different heavy-quark-coupling mechanisms to the QGP.

## References

- [1] H. Petersen, J. Steinheimer, G. Burau, M. Bleicher and H. Stoecker, Phys. Rev. C **78** (2008) 044901
- [2] S. A. Bass, A. Dumitru, M. Bleicher, L. Bravina, E. Zabrodin, H. Stoecker and W. Greiner, Phys. Rev. C **60** (1999) 021902
- [3] H. van Hees and R. Rapp, Phys. Rev. C **71** (2005) 034907
- [4] T. Lang, H. van Hees, J. Steinheimer and M. Bleicher, arXiv:1211.6912 [hep-ph].
- [5] H. van Hees, M. Mannarelli, V. Greco and R. Rapp, Phys. Rev. Lett. **100** (2008) 192301

\* Work supported by H-QM, HIC for FAIR, GSI Helmholtzzentrum, Office of Nuclear Physics in the US Department of Energy's Office of Science under Contract No. DE-AC02-05CH11231, Bundesministerium für Bildung und Forschung (BMBF) grant No. 06FY7083